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PATENT ABSTRACTS OF JAPAN

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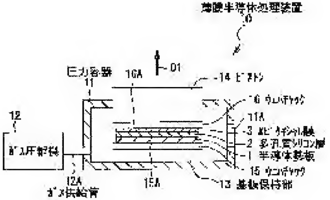
(54) **THIN FILM SEMICONDUCTOR PROCESSOR**

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a thin film semiconductor processor where an epitaxial film can easily be peeled from a single crystal silicon substrate in a porous silicon layer while the damage to the epitaxial film is suppressed as much as possible at the time of manufacturing a thin film semiconductor element.



SOLUTION: The thin film semiconductor processor 10 is provided with a gas compressor 12 and a pressure container 11. A substrate holder 13 is fixed to a base in the pressure container 11, and a piston 14 which can be displaced in a vertical direction is arranged on an upper face. The back of a semiconductor substrate is closely stuck to the wafer chuck 15 of the substrate holder 13 and the surface of the epitaxial film 3 to the wafer chuck 16 of the piston 14. Thus, a semiconductor substrate 1 is held. Compressed gas supplied from the gas compressor 12 to the pressure container 11 passes through the gap of the porous silicon layer 2. Thus, pressure is applied to the epitaxial film 3 in the vertical direction, and the epitaxial film 3 is pushed upward with the piston 14 and is

peeled from the semiconductor substrate 1.

JAPANESE [JP,2002-231980,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

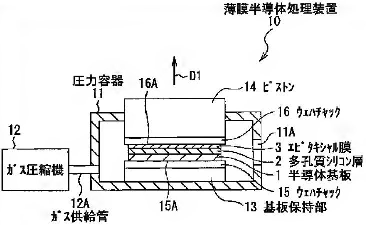
[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1]A thin film semiconductor processing unit comprising:
A container which has an attaching part holding a semiconductor substrate by which a semiconductor device composition film was formed in the surface on a porosity semiconductor layer and said porosity semiconductor layer, respectively.
A feeding means which supplies compressed gas in said container so that said semiconductor device composition film may exfoliate from said semiconductor substrate in said porosity semiconductor layer.

[Claim 2]The 1st supporter by which said attaching part adsorbs a field in which said porosity semiconductor layer of said semiconductor substrate is formed, and a field of an opposite hand, The thin film semiconductor processing unit according to claim 1 being constituted by the 2nd supporter that adsorbs a field in which said porosity semiconductor membrane of said semiconductor device composition film is formed, and a field of an opposite hand.

Drawing selection Representative draw



[Translation done.]

[Claim 3]The thin film semiconductor processing unit according to claim 2, wherein said 1st and 2nd supporters have an electrostatic adsorption type or vacuum absorption type wafer chuck, respectively.
[Claim 4]The thin film semiconductor processing unit according to claim 1, wherein said feeding means supplies gaseous helium or hydrogen gas as said compressed gas.
[Claim 5]The thin film semiconductor processing unit according to claim 1, wherein said feeding means supplies said compressed gas so that a pressure may be vertically added from said porosity semiconductor layer side to the surface of said semiconductor device composition film towards said semiconductor device composition film.
[Claim 6]The thin film semiconductor processing unit according to claim 2 having a generating means which prints in said porosity semiconductor layer and generates stress by applying power in the direction parallel to the surface to at least one of said 1st supporter or the 2nd supporter.
[Claim 7]The thin film semiconductor processing unit according to claim 6 characterized by said thing [printing and generating stress] when said generating means vibrates at least one of said 1st supporter or the 2nd supporter.
[Claim 8]The thin film semiconductor processing unit according to claim 2 having a means to apply power to either said 1st supporter or the 2nd supporter, from a direction opposite to the direction of a pressure added to the surface of said semiconductor device composition film.

[Translation done.]

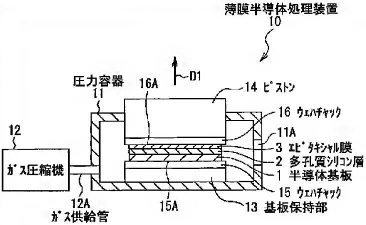
JAPANESE [JP,2002-231980,A]

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]When this invention manufactures thin film semiconductor elements, such as a solar battery element, it relates to the thin film semiconductor processing unit for exfoliating an epitaxial film from a semiconductor substrate.
[0002]
[Description of the Prior Art]In recent years as a method of manufacturing the solar battery element using a single-crystal-silicon thin film, For example, a porosity (porous) silicon layer is formed on the surface of a single crystal silicon substrate, After forming the photoelectric conversion part which consists of a single-crystal-silicon thin film (epitaxial film) on this porous silicon layer and pasting up a plastic film on this photoelectric conversion part, some which exfoliate this photoelectric conversion part from a single crystal silicon substrate are with tensile stress (JP,8-213645,A). By using this method, it is possible to obtain the flexible solar battery element formed in a plastic film, a paper sheet, etc.

Drawing selection Representative draw



[Translation done.]

[0003]
[Problem(s) to be Solved by the Invention]By the way, in the above-mentioned manufacturing method, exfoliation of the photoelectric conversion part from the single crystal silicon substrate in the porous silicon layer which has stratum disjunctum is performed by hand. However, in a field in the tensile strength of the stratum disjunctum of a porous silicon layer, since it is not uniform, in the case of this exfoliation, adjustment of delicate power is needed. Therefore, it is not easy to automate this exfoliation and there is a problem of being unsuitable in mass production. Since the plastic film which should be pasted up on a photoelectric conversion part before exfoliation cannot bear an elevated temperature, after the plastic film has pasted up, there is a problem that only processing at low temperature can be performed. Therefore, for example, in processing in elevated temperatures, such as soldering, the processing using a printed circuit board is needed as indicated to JP,9-255487,A.
[0004]There is the method of exfoliating the single-crystal-silicon thin film from the single crystal silicon substrate in a porous silicon layer by a water jet (JP,11-045840,A, JP,2000-100680,A). However, in this method, that exfoliation takes time and there is a problem of cracking a single-crystal-silicon thin film with water pressure.
[0005]This invention was made in view of this problem, and the purpose, It is in providing the thin film semiconductor processing unit which can perform easily that an epitaxial film damages exfoliation of the epitaxial film from the single crystal silicon substrate in a porous silicon layer in the case of manufacture of thin film semiconductor elements, such as a solar battery element, while stopping as much as possible.
[0006]
[Means for Solving the Problem]A thin film semiconductor processing unit by this invention is provided with the following.
A container which has an attaching part holding a semiconductor substrate by which a semiconductor device composition film was formed in the surface a porosity semiconductor layer and on this porosity semiconductor layer, respectively.
A feeding means which supplies compressed gas in a container so that a semiconductor device composition film may exfoliate from a semiconductor substrate in a porosity semiconductor layer.

[0007]In a thin film semiconductor processing unit by this invention, after a porosity semiconductor layer and a semiconductor substrate by which a semiconductor device

composition film was formed on this porosity semiconductor layer, respectively are held on the surface at an attaching part in a container, compressed gas is supplied by feeding means in this container. Thereby, in a porosity semiconductor layer, a semiconductor device composition film exfoliates from a semiconductor substrate.

[0008]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described in detail with reference to drawings.

[0009][A 1st embodiment] Drawing 1 expresses the outline composition of the thin film semiconductor processing unit 10 concerning a 1st embodiment of this invention. This thin film semiconductor processing unit 10 is for performing exfoliation processing to the semiconductor substrate 1 used when manufacturing thin film semiconductor elements, such as a solar battery element. The semiconductor substrate 1 which is the target of exfoliation processing consists of single crystal silicon, for example, and the epitaxial film 3 is formed in the surface of this semiconductor substrate 1 for example, by an anodization method, and it is formed by epitaxial growth on the porous silicon layer 2 and the porous silicon layer 2, respectively. The above-mentioned exfoliation processing is for exfoliating the epitaxial film 3 from the semiconductor substrate 1 in the stratum disjunctum (not shown) of this porous silicon layer 2. The porous silicon layer 2 is formed so that the rate of porosity-izing (Poral city) and a crevice may become large, so that the epitaxial film 3 can be exfoliated by small power (tensile stress).

[0010]The thin film semiconductor processing unit 10 is provided with the pressure vessel 11, and the gas-compression machine 12 is connected with this pressure vessel 11 via the gas supply line 12A. The substrate attaching part 13 is being fixed to the bottom in the pressure vessel 11. The upper surface in the pressure vessel 11 is countered at the substrate attaching part 13, and the piston 14 is formed. By the support member (not shown), this piston 14 is supported by the sliding direction so that displacement is possible.

[0011]The pressure vessel 11 can bear now the pressure of about 20 or more MPa, for example. The gas-compression machine 12 consists of compressors, for example, and lets the gas supply line 12A pass, for example, supplies the compressed gas of the pressure of about 1 MPa - 20MPa (tens kg/cm^2 - hundreds kg/cm^2) within the limits to the pressure vessel 11. As this compressed gas, what can pass the crevice in the porous silicon layer 2, for example, air, is used. In addition, the gas of the molecule whose molecular

weight is smaller than N_2 (molecular weight 28) or O_2 (molecular weight 32), such as helium (helium) or hydrogen (H_2), etc. may be used. The direction of such gas is because it is easy to pass the crevice in the porous silicon layer 2 with large rate of porosity-izing and crevice.

[0012]Incidentally, tensile stress and the intensity [as opposed to / print and / stress] of single crystal silicon of bulk are about 200 MPa(s) (2000 kg/cm^2), for example. However, since the porous silicon layer 2 has many crevices, it is smaller than the case of the single crystal silicon of bulk, for example, are about 0.5 MPa(s) (tens kg/ cm^2). [of the intensity] Therefore, the pressure of the compressed gas supplied from the gas-compression machine 12 serves as the above-mentioned value within the limits higher than this intensity.

[0013]The substrate attaching part 13 is for carrying and holding the semiconductor substrate 1, adsorbs the rear face (undersurface) of the semiconductor substrate 1, for example, contains the electrostatic adsorption type wafer chuck 15 so that the semiconductor substrate 1 may not separate in the case of exfoliation of the epitaxial film 3. The piston 14 is displaced to above [which is shown by an arrow with the compressed gas supplied from the gas-compression machine 12 / D1] (it is a vertical direction to the surface of the semiconductor substrate 1), and is because the epitaxial film 3 is pulled apart from the semiconductor substrate 1. This piston 14 adsorbs the surface (upper surface) of the epitaxial film 3, for example, contains the electrostatic adsorption type wafer chuck 16 so that the epitaxial film 3 may not separate from the piston 14 in the case of exfoliation. The wafer chuck 15 has the smooth adsorption face 15A and the adsorption face 16A smooth in the wafer chuck 16, respectively. The adsorption face 15A is stuck with the rear face of the semiconductor substrate 1, the adsorption face 16A is stuck with the surface of the epitaxial film 3, respectively, and compressed gas is kept from entering by this between the adsorption face 15A and the rear face of the semiconductor substrate 1, and between the adsorption face 16A and the surface of the epitaxial film 3. As for the adsorption power of the wafer chucks 15 and 16, below about 1 MPa (several kg/cm^2) is about 0.5 MPa(s) (5 kg/cm^2). It may be made to provide the vacuum absorption type wafer chuck which consists of porosity ceramics, for example instead of these wafer chucks 15 and 16, respectively. The semiconductor substrate 1 has come to be able to perform insertion or extraction through the entrance 11A established in the pressure vessel 11.

[0014]Next, an operation of the thin film semiconductor processing unit 10 constituted as mentioned above is

explained.
[0015]The semiconductor substrate 1 in which the porous silicon layer 2 and the epitaxial film 3 were formed is inserted into the pressure vessel 11 through the entrance 11A, and is held at the substrate attaching part 13. Under the present circumstances, the rear face of the semiconductor substrate 1 is stuck to the adsorption face 15A by adsorption of the wafer chuck 15, and the surface of the epitaxial film 3 is stuck to the adsorption face 16A by adsorption of the wafer chuck 16 of the piston 14. Compressed gas is kept from entering into the crevice between the adsorption face 15A of the wafer chuck 15, and the rear face of the semiconductor substrate 1, and the crevice between the adsorption face 16A of the wafer chuck 16, and the surface of the epitaxial film 3 by this, respectively.
[0016]In this state, the compressed gas of a predetermined pressure is supplied to the pressure vessel 11 through the gas supply line 12A from the gas-compression machine 12. Under the present circumstances, since there are many crevices in the porous silicon layer 2, compressed gas enters into the crevice between the porous silicon layers 2, and a pressure is added from the porous silicon layer 2 side to the semiconductor substrate 1 and the epitaxial film 3, respectively. Thereby, since the differential pressure power by the side of the wafer chuck 16 and the porous silicon layer 2 is added to the epitaxial film 3, the epitaxial film 3 is made above [D1] with the piston 14, and the epitaxial film 3 exfoliates from the semiconductor substrate 1. the pressure of the compressed gas supplied to the pressure vessel 11 is changed to two or more stages (for example, it is made to go up gradually) -- it may be made like.
[0017]As mentioned above, at the above-mentioned embodiment, where the epitaxial film 3 is stuck to the adsorption face 16A of the wafer chuck 16, in the porous silicon layer 2, the epitaxial film 3 is exfoliated from the semiconductor substrate 1 by supplying compressed gas. Therefore, even if the pressure added to the epitaxial film 3 from the porous silicon layer 2 side is uneven in a field, it can prevent receiving the damage to the epitaxial film 3 breaking etc. as much as possible. Since it is stuck in the smooth adsorption face 16A, the epitaxial film 3 can be performed suppressing generating of the damages of exfoliation of the epitaxial film 3 to the crack as much as possible, even when the tensile strength distribution within the field of the porous silicon layer 2 is uneven.
[0018]By the thing it is made to make this gas enter for a short time at the crevice between the porous silicon layers 2 using the gas of a molecule with the above molecular weights small as compressed gas. The pressure in the porous silicon layer 2 can be made high in a short time, and a

pressure can be uniformly applied to the epitaxial film 3. Therefore, it becomes possible to perform the exfoliation, without producing the damage to a crack etc. as much as possible in the epitaxial film 3.

[0019]Since the epitaxial film 3 is exfoliated with compressed gas, without using a plastic film etc., for example, processing in an elevated temperature is attained to the epitaxial film 3 in the state where it was made to stick to the wafer chuck 16 after exfoliation. What is necessary is just to provide beforehand what can bear the temperature of processing as the wafer chuck 16.

[0020]Although it is necessary to perform alignment to a porous silicon layer further again by the method of exfoliating an epitaxial film, for example using a water jet, According to the above-mentioned embodiment, an epitaxial film can be exfoliated easily, without performing alignment to a porous silicon layer, since the pressure (tensile stress) by compressed gas is used.

[0021][A 2nd embodiment] Drawing 2 expresses the outline composition of the thin film semiconductor processing unit concerning a 2nd embodiment of this invention. Here, the same numerals are given to the same component as a 1st embodiment, and only a different portion is explained to it.

[0022]As compared with the thin film semiconductor processing unit 10, further, the thin film semiconductor processing unit 20 of this embodiment was formed in the pressure vessel 11, and is provided with the excitation apparatus 21 connected with the substrate attaching part 13 via the connecting member 22. The elastic plate 23 which consists of rubbers, for example has pasted the bottom in the pressure vessel 11 with the binder. The substrate attaching part 13 is pasted up with adhesives on the elastic plate 23.

[0023]The excitation apparatus 21 vibrates the substrate attaching part 13 in the parallel direction (field inboard) to the surface of the semiconductor substrate 1 via the connecting member 22. The elastic plate 23 is because vibration of the substrate attaching part 13 is enabled.

[0024]In the thin film semiconductor processing unit 20 constituted as mentioned above. Where the semiconductor substrate 1 is held with the substrate attaching part 13 and the piston 14, from the gas-compression machine 12, compressed gas is supplied to the pressure vessel 11 through the gas supply line 12A, and the substrate attaching part 13 is vibrated to field inboard via the connecting member 22 with the excitation apparatus 21. Since it prints to the epitaxial film 3 at tensile stress and the porous silicon layer 2 and stress arises by this, with the piston 14, the epitaxial film 3 is made above [D1], and exfoliates from the semiconductor substrate 1.

[0025]As mentioned above, at the above-mentioned

embodiment, where the semiconductor substrate 1 is held with the substrate attaching part 13 and the piston 14, compressed gas is supplied in the pressure vessel 11, and the substrate attaching part 13 is vibrated. Therefore, compared with the case where only supply of compressed gas is performed, the epitaxial film 3 from the semiconductor substrate 1 in the porous silicon layer 2 can be more easily exfoliated like the above-mentioned thin film semiconductor processing unit 10.

[0026]It is also possible by vibrating the substrate attaching part 13 with the excitation apparatus 21, printing to the porous silicon layer 2, and producing stress to exfoliate the epitaxial film 3 from the semiconductor substrate 1, without supplying compressed gas. In addition, the excitation apparatus 21 is connected with the piston 14 via the connecting member 22, and it may be made to vibrate the piston 14 with the excitation apparatus 21. The excitation apparatus 21 is possible also for connecting another excitation apparatus with the piston 14, and making it vibrate simultaneously the substrate attaching part 13 and the piston 14. It may be made to exfoliate instead of the excitation apparatus 21 by applying power only in the predetermined direction to the substrate attaching part 13 with supply of compressed gas about the epitaxial film 3 using the device which applies power (tensile force or pressing force) only in the predetermined direction of [within a field] to the substrate attaching part 13.

[0027][A 3rd embodiment] Drawing 3 expresses the outline composition of the thin film semiconductor processing unit concerning a 3rd embodiment of this invention. Here, the same numerals are given to the same component as 1st and 2nd embodiments, and only a different portion is explained to it.

[0028]The thin film semiconductor processing unit 30 of this embodiment is further provided with the pressure vessel 31, the gas-compression machine 32, and the control section 34 as compared with the thin film semiconductor processing unit 10. The pressure vessel 31 is connected with the upper part of the pressure vessel 11 by the connecting part 33. The gas-compression machine 32 is connected with the pressure vessel 31 via the gas supply line 32A. The piston 14 is formed so that the upper part may project in the pressure vessel 31.

[0029]The pressure vessel 31 has the same composition as the pressure vessel 11, and can bear now a pressure comparable as the pressure vessel 11. The gas-compression machine 32 has the same composition as the gas-compression machine 12, lets the gas supply line 32A pass, supplies the compressed gas of a pressure comparable as the gas-compression machine 12 to the pressure vessel 31, and

applies a pressure to down [D2] to the piston 14. The control section 34 controls a motion of the sliding direction of the piston 14 by adjusting the pressure of the compressed gas from the gas-compression machines 12 and 32.
[0030]In the thin film semiconductor processing unit 30 constituted as mentioned above. Where the semiconductor substrate 1 is held with the substrate attaching part 13 and the piston 14, the compressed gas of a comparable pressure is supplied to the pressure vessels 11 and 31 by control of the control section 34 through the gas supply lines 12A and 32A from the gas-compression machines 12 and 32. It is made not to displace the piston 14 by this by a respectively comparable pressure being added to above [D1] and down [D2] to the piston 14. And after the pressure in the porous silicon layer 2 becomes high enough, only the pressure of the compressed gas supplied to the pressure vessel 31 from the gas-compression machine 32 is decreased by control of the control section 34. Here, a pressure is lowered to atmospheric pressure. Thereby, with the piston 14, the epitaxial film 3 is made above [D1], and exfoliates from the semiconductor substrate 1.
[0031]As mentioned above, in the above-mentioned embodiment, hold the semiconductor substrate 1 with the substrate attaching part 13 and the piston 14, and supply the compressed gas from the gas-compression machine 12 in the pressure vessel 11, and. In the state where supply the compressed gas from the gas-compression machine 32 to the pressure vessel 31, and it was made not to displace the piston 14, the pressure of the compressed gas from the gas-compression machine 32 is decreased. Therefore, the pressure in the porous silicon layer 2 can be made high enough before exfoliation of the epitaxial film 3, and it becomes possible to apply power uniformly in a field. Only some fields can be prevented from the epitaxial film 3 breaking and exfoliating by this. Peel strength (tensile strength) receives the uneven porous silicon layer 2 in a field, Where the pressure which is a grade which can fully be exfoliated also in a portion with the largest peel strength is applied, As mentioned above, it becomes possible to exfoliate without producing the damage to a crack of an epitaxial film etc. from the gas-compression machine 32 as much as possible by making it decrease only the pressure of the compressed gas supplied to the pressure vessel 31.
[0032]Since a pressure sufficiently higher than the minimum exfoliation pressure required for exfoliation can be applied, it becomes possible to send in compressed gas in the porous silicon layer 2 for a short time, and to exfoliate the epitaxial film 3 rather than the case of the above-mentioned thin film semiconductor processing units 10 and 20. Therefore, the exfoliation time of the epitaxial film 3 can

be shortened. As long as it makes it the minimum pressure to the porous silicon layer 2 become higher than the minimum exfoliation pressure in this case, the pressure distribution within the field in the porous silicon layer 2 may be uneven.

[0033]It may be made to use the pressurizer based on other principles in the thin film semiconductor processing unit 30 instead of using the pressure vessel 31 and the gas-compression machine 32, since power should just be applied to down [D2] to the piston 14.

[0034]It is also possible to use the thin film semiconductor processing unit 40 as shown in drawing 4 instead of the above-mentioned thin film semiconductor processing unit 30. Apply a pressure from the upper and lower sides so that the thin film semiconductor processing unit 40 may double the function of the thin film semiconductor processing unit 20, and may be constituted by the function of the thin film semiconductor processing unit 30 and the piston 14 may not be displaced, and. Where the substrate attaching part 13 is vibrated, the pressure from the piston 14 is decreased. Therefore, compared with the case of the above-mentioned thin film semiconductor processing units 10, 20, and 30, the epitaxial film 3 from the semiconductor substrate 1 in the porous silicon layer 2 can be exfoliated more easily.

[0035]As mentioned above, although the embodiment of the invention was described, various modification is possible for this invention, without being limited to the above-mentioned embodiment. For example, although he is trying to make the rear face of the semiconductor substrate 1, and the adsorption face 16A of the wafer chuck 16 of the piston 14 stick the surface of the epitaxial film 3 to the adsorption face 15A of the wafer chuck 15 of the substrate attaching part 13 in the above-mentioned embodiment, respectively, On the contrary, to the adsorption face 15A of the wafer chuck 15 of the substrate attaching part 13, flip vertical of the semiconductor substrate 1 may be carried out, and it may be arranged so that the rear face of the semiconductor substrate 1 may be stuck to the surface of the epitaxial film 3, and the adsorption face 16A of the wafer chuck 16 of the piston 14, respectively.

[0036]

[Effect of the Invention]As explained above, according to the thin film semiconductor processing unit of this invention, on the surface A porosity semiconductor layer, Since compressed gas was supplied in the container by the feeding means after holding the semiconductor substrate by which the semiconductor device composition film was formed on the porosity semiconductor layer, respectively to the attaching part in a container, For example, it can carry out easily, suppressing generating of damage of exfoliation

of the epitaxial film from the single crystal silicon substrate in a porous silicon layer to an epitaxial film as much as possible in the case of manufacture of a solar battery element.

[Translation done.]